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TWO NEW FLAGELLATES FROM TERMITES
IN THE
GENERA CORONYMPHA KIRBY, AND METACORONYMPHA
KIRBY, NEW GENUS.

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During the cruise of the *Zaca* to Central America, Mexico, and the Galapagos Archipelago, termites were collected by Dr. A. E. Larsen, who also prepared smears of their intestinal Protozoa. A report on these termites, by S. F. Light, has been published in this series. The smears of Protozoa were submitted to the writer for study and report. Among them are preparations from *Kaloterme pacificus* Banks, which contains some unusually interesting multinucleate flagellates. These were collected on James Island and Albemarle Island of the Galapagos Archipelago.

The flagellates of *K. pacificus* are the same as those collected by the writer in 1925 from termites on Taboga Island, Panama, determined by T. E. Snyder as *Kaloterme tabogae*. Light (1935) concluded that *K. tabogae* is synonymous with *K. pacificus*, an opinion which is not opposed by a study of the protozoan faunas.

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The same flagellates have been found in *Kaloterme emersoni* Light and *K. platycephalus* Light, collected by Light in the State of Colima, Mexico, in 1930 and sent to the writer for preparation of smears; and in *K. lighti* Snyder collected by Light at Ray, Arizona, in 1929.

The only other species of the subgenus *Kaloterme sensu stricto*, to which all the above termites belong, that has been found on the Galapagos Islands is *K. immigrans* Snyder; excepting *K. galapagoensis* Banks which, according to Light (1935), is a *species inquirenda*. Protozoa of *Kaloterme immigrans* were obtained by the writer at Fanning Island in 1924, and by Dr. Larsen at Chatham, Narborough, Jervis, South Seymour, James, and Tower Islands of the Galapagos Archipelago. The genus *Coronympha* was established by the writer (1929) for the species *clevelandi* in this termite of Fanning Island, as well as in *Kaloterme clevelandi* Snyder of Panama and in *Kaloterme* sp. of the Galapagos Archipelago. The last host was doubtless also *K. immigrans*.

The flagellates found in these termites belong to a peculiar group of the Calonymphidae. They differ from *Stephanonympha* and *Calonympha*, the common genera of the family, in having conspicuous crests and axostyles that are not gathered into a bundle. Each mastigont has essentially the structure of the mastigont of a devescovid flagellate; they may, in fact, be regarded as polymastigont devescovidids, in the same way that *Microrhopalodina* is a polymastigont oxymonad.¹

Each of the species *K. pacificus*, *K. tabogae*, *K. lighti*, *K. emersoni*, and *K. platycephalus* contains two species of these flagellates, one a species of *Coronympha*, and the other of the new genus *Metacoronympha*. In addition, *Tricercomitus* and *Oxymonas* are present in all; *Trichonympha* was found in all except *K. lighti*. The absence of *Trichonympha* from the one colony examined does not, of course, indicate that it is absent from the species. The six or seven species of termites containing *Coronympha* and *Metacoronympha* are the only ones of about a hundred members of the genus *Kaloterme sensu lato* examined by the writer that were found to lack a representative of the subfamily Devescovidinae.

Reference was made to these Protozoa by Light (1933) in his account of *Kaloterme emersoni* and *K. platycephalus*, using data supplied by the writer. *Metacoronympha* was incorrectly listed there as *Stephanonympha*. The genus name *Metacoronympha* was given in a list of genera prepared by the writer (1937) in a survey of host parasite relations in the distribution of Protozoa in termites.

Financial assistance in preparation of the drawings illustrating this paper has been given by the Research Board of the University of California and the National Research Council.

¹ Duboscq and Grassé (1933, p. 448) state that *Coronympha* is a "*Eutrichomastix* polyénergide." The more immediate relationship is probably to Devescovidinae, and through that group to *Monocercomonas* (= *Eutrichomastix*).

***Coronympha octonaria* Kirby, new species**

Plate 36, figures 1-8

Coronympha clevelandi (pl. 36, fig. 9) contains sixteen karyomastigonts arranged in a circle. *C. octonaria* agrees with *C. clevelandi* in every way except that there are only eight karyomastigonts. A few specimens have been found with ten or twelve, but this is unusual. None has been seen with sixteen, unless in a division stage.

The species is somewhat smaller, and especially more slender, than *C. clevelandi*. Whereas that species has a range from 25 to 53 μ in length, and 18 to 46 μ in width, averaging 30 by 23 μ , fifty specimens of *C. octonaria* from *K. emersoni* ranged from 19 to 40 μ in length, and 14 to 26 μ in width, averaging 28 by 18.6 μ ; and fifty from *K. lighti* were 20 to 35 μ in length, 12 to 22 μ in width, averaging 27 by 16.4 μ .

Each karyomastigont consists of a nucleus, blepharoplast, cresta, three slender flagella and one stout flagellum, parabasal body and axostyle.

The eight pyriform nuclei are arranged in a circle (pl. 36, fig. 2), the longitudinal axis of each at an angle to the longitudinal axis of the body, so that the circle formed by their anterior ends is smaller than that formed by their posterior ends. A nucleolus can be distinguished in each nucleus in sufficiently destained material.

The blepharoplasts are arranged in a circle whose diameter is considerably smaller than that formed by the inner ends of the nuclei. The crestas (pl. 37, fig. 4A) are like those of many devescoviniid flagellates, subtriangular in form, the broader proximal end flattened, the distal end slender. The cresta (chromatic rod) of *C. clevelandi* (pl. 37, fig. 4B) is not rounded proximally, as stated in the original description (Kirby, 1929). Reexamination of the material has shown that the crestas are shaped like those of *C. octonaria*, though somewhat smaller in size.

The trailing flagellum is a moderately stout cord except in its anterior and posterior portions, where it is slender. The anterior portion lies close against the outer edge of the cresta, which is at the surface of the body. Usually it cannot be distinguished from it, so that flagellum and cresta seem to be continuous, and the form and length of the latter cannot be ascertained. Specimens can be found, however, in which the two are at least partially separated. The three long, fine, anterior flagella are ordinarily adherent, at least in their proximal portion.

The bacilliform parabasal bodies (pl. 36, figs. 3, 4) are each situated against the peripheral side of a nucleus, and, when long, are curved so that the concave side is outward. There is much variation in size. Ordinarily the parabasals generally are almost or quite as long as the nuclei; sometimes they exceed that length. They are larger than those of *Coronympha clevelandi*. Material of *C. clevelandi* was studied again to check the accuracy of the description published

in 1929. In some the parabasals are more bacilliform than was indicated then, but none was observed to equal or exceed the nucleus in length.

The axostyles are like those of *C. clevelandi*, being broad enough to permit the sheath and a clear interior to be distinguished. They run through the endoplasm, but are not gathered into a compact bundle, and often project posteriorly for a short distance. There is no terminal enlargement.

A number of division stages were found in material from *Kaloterms emersoni* (pl. 36, figs. 5-7). At the onset of division the nuclei leave their position in the anterior circle, and become distributed in the peripheral cytoplasm. In all cases observed but one eight nuclei were so distributed. This one had seven. In all division figures observed a stout flagellum was attached at one end of the paradesmose. Evidently as in *Devescovina* the trailing flagellum is not discarded; the old flagella are distributed, and new ones grow out to complete the supply.

When nuclear division has been completed the sixteen nuclei are distributed in two groups of eight to opposite ends of the body, and form into circles from which the now full-grown new crestas radiate and the groups of new axostyles extend posteriorly (pl. 36, fig. 8). Plasmotomy then occurs.

Abnormal numbers of nuclei would result if this distribution were not equal. When there are ten, at the previous division six may have gone to one end and ten to the other, assuming that the parent had sixteen. Division and equal distribution of all the nuclei in a flagellate with ten or twelve would perpetuate the number. The very small number of instances of such numbers of nuclei indicate that unequal distribution seldom occurs.

There is no evidence that the nuclei divide in a flagellate that is not as a whole undergoing binary fission. But since little division material has been found, such a possibility cannot be denied.

It is probable that a species of *Coronympha* with four karyomastigonts exists or has existed in *Kaloterms*. That is one thing to search for in unexplored termites. The series would be completed by the discovery of a flagellate with two karyomastigonts of this type.

Metacoronympha senta Kirby, new genus, new species

Plate 37, figures 1-6; Plate 38, figures 1-5; Plate 39, figures 1-10

Those hosts here studied which contain *Coronympha octonaria* also have this larger flagellate. There is, however, no question of the two being developmental stages of the same species. In *Kaloterms immigrans* and *K. clevelandi*, *Coronympha clevelandi* is the only multinucleate flagellate.

Metacoronympha senta has a stout body that is more broadly rounded anteriorly than posteriorly. The posterior end is often

more or less bluntly pointed. Fifty specimens from *Kaloterme emersoni* ranged in length from 32 to 77 μ , in width from 20 to 66 μ , averaging 51 by 38 μ . Fifty from *K. tabogae* (= *K. pacificus*?) ranged from 22 to 92 μ by 15 to 67 μ , averaging 40.5 by 30 μ . There were many more small forms, as well as some larger forms, in the material from *K. tabogae*.

The anterior end of the body is occupied by the numerous karyomastigonts in regular arrangement, located in the peripheral cytoplasm (pl. 38, fig. 1; pl. 39, fig. 1). There are always a great many more than eight, and they are never arranged in a circle, nor in concentric circles. The number varies greatly. One of the largest specimens from *Kaloterme tabogae* contained 345 karyomastigonts (pl. 37, fig. 6), and one of the smallest (pl. 37, fig. 2) had 66. Four specimens from *Kaloterme emersoni* had 134, 127, 100, and 95 (pl. 38, fig. 4). The one drawn from *K. platycephalus* (pl. 38, fig. 3) had 144. The average number is under a hundred and fifty.

The karyomastigonts are arranged in dextrotropic spiral rows, turning over to the right as observed from the anterior end. The nuclei in the rows are usually evenly and regularly spaced. Of fifty specimens, seven had five rows (pl. 37, fig. 2), thirty-four had six (pl. 38, fig. 4), seven had seven (pl. 38, fig. 3), and one each had eight and nine (pl. 37, fig. 6). The last had only six rows at the center of the spiral. Six, then, is the usual number.

In suitably stained material it can be observed that the chromatin masses of the nuclei are situated within contiguous polygonal compartments (pl. 38, fig. 2) in an arrangement that calls to mind the structure of the surface layer of a *Volvox* colony. That is, however, merely an analogy. The polygonal boundaries are formed by the nuclear membranes, which have expanded, leaving a considerable area around the central chromatin masses, and have become angular as a result of being pressed together. That this is really the case has been proved by observation of stages just after division (pl. 39, fig. 10), in which the nuclei have not yet become organized into position. The membranes are then spherical, or nearly so, and surround the chromatin more closely, but in the specimen drawn some have begun to expand. Certain of the drawings (pl. 38, fig. 4; pl. 39, fig. 1) are not accurate in respect to the nuclear membranes, which should be contiguous as described above.

In flagellates with a small or average number of karyomastigonts the nuclei are usually all of approximately the same size (pl. 37, figs. 1, 2, 5; pl. 38, fig. 4); but in those with an exceptionally large number the nuclei decrease in size toward the anterior end of the spiral rows (pl. 37, fig. 6; pl. 38, fig. 3).

The crestas are the most conspicuous structures in a flagellate stained in iron haematoxylin and destained to the point where they alone remain black. They stain more intensely than the chromatin of the resting nucleus. Their shape suggests that of thorns, so that in such preparations the anterior portion has a thorny appearance.

Of course, the crestas are imbedded in the peripheral cytoplasm, and do not project. The specific name has been selected because of this appearance in certain Heidenhain's iron haematoxylin material.

In shape the crestas have a general resemblance to those of *Coronympha*. They are variable in size (pl. 37, fig. 4, C), and in some the antero-medial edge is longer than in other crestas of the same total length. In flagellates with a large number of karyomastigonts the crestas of the anterior ones may be very small, the size increasing in the more posterior ones. Figure 4, C, 5, 6, and 7 shows the crestas in three karyomastigonts of a single specimen from *Kaloterme tabogae*.

As in *Coronympha*, the more slender proximal part of the trailing flagellum is usually indistinguishable from the cresta. The trailing flagellum is not so stout as those of *C. clevelandi* and *C. octonaria* (pl. 37, fig. 4). The three anterior flagella of each karyomastigont arise in one group, and are united proximally. In the fixed material observed they were always separated in the distal portion, the separation sometimes beginning not far from the point of origin.

The axostyles show no tendency, as in *Stephanonympha* and *Calonympha*, to collect in a bundle as they run through the body. Each trunk runs separately from the others, and they are more peripherally located than in *Coronympha*. Generally they are in the outer endoplasm. They project when they reach the boundary of the body. This may be at the posterior end of the flagellate, as is usual, but only occasionally are they gathered close together here. Certain axostyles may fall short of the length of some of the others, and project before they reach the posterior end. It is seldom that they do not project at all.

At the posterior end the trunk of the axostyle is enlarged in a spearhead-formed cusp (pl. 39, fig. 2). Usually enlargement begins before it reaches the boundary of the cytoplasm; the edge of the cytoplasm is at the broadest point. Beyond is a comparatively long tapering projection. The anterior portions of the axostyles, alongside the nucleus, could not be studied satisfactorily. The slender trunk runs to the posterior end of the nucleus without any noticeable change in diameter.

The presence of this enlarged cusp at the posterior end of the axostyle is a frequent characteristic in flagellates of termites. It does not exist in certain genera of the subfamily Devescovinae, namely, *Devescovina*, *Macrotrichomonas*, *Caduceia*, and *Pseudodevescovina*, but it does occur in many undescribed species of *Foaina* and in *Metadevescovina*. Outside of the Devescovinae it has been noted in a number of other polymastigotes, and in some hypermastigotes.

No such cusps are present in *Coronympha octonaria*. A reexamination of *Coronympha clevelandi* was made, and the original description corroborated in respect to their absence in that species also. In *Coronympha* the axostyles taper gradually to the projecting tips,

which usually extend beyond the cytoplasm for a short distance, but may be completely enclosed.

The cytoplasm of both *Coronympha* and *Metacoronympha* usually contains an abundance of fragments of wood. Many particles are relatively large, and these grade down to very small ones. All of these seem to be imbedded directly in the cytoplasm. There are no large food vacuoles. A narrow clear space surrounds each one, as is true of other cytoplasmic inclusions. Among them, or instead of them, there may be smoothly or unevenly rounded spherules of variable size (pl. 38, fig. 5). These are of heterogeneous constitution. In iron haematoxylin stained material granules, or less often bacilliform bodies, for the most part peripherally located, stain deeply, the remainder lightly or not at all. The deeply stainable components are relatively more abundant in some spherules, less abundant in others. Some smaller bodies stain deeply and uniformly. Such spherules, which probably represent phases of wood digestion, were particularly abundant in some material from *Kaloterme tabogae*, where there were comparatively few particles of wood among them.

The outer surface of the body in *Metacoronympha*, as in *Coronympha*, is not marked by any type of regularly adherent micro-organism. Spirochaetes are usually present against the body as well as in the vicinity, but they do not adhere in a definite tuft or coat as in many other flagellates of termites.

DIVISION

Among the Calonymphidae, nuclear division was observed by Janicki (1915) in *Stephanonympha silvestrii* and *Calonympha grassii*. He reported that division occurs simultaneously in all nuclei, and the dividing nuclei are distributed irregularly throughout the peripheral cytoplasm. The anterior parts of the axostyles are resorbed, while the compact bundle composed of the posterior parts persists for a while. An extranuclear spindle develops with granules at its ends, to which flagella are attached. Chromosomes appear, which are granular in form and of unknown number in *S. silvestrii*, band-formed and four or five in number in *C. grassii*. The old parabasal body persists at one pole, while a new one develops at the other. Janicki believed that the new axostyles originate by direct transformation of the extranuclear spindle.

Considerably more division material of *Metacoronympha senta* has been found than of *Coronympha octonaria*. It likewise occurred on several slides from *Kaloterme emersoni*. No attempt has been made to obtain conclusive evidence on all points. The writer expects to make a complete study of division of the Calonymphidae, based on an abundance of material from many termites.

In *Metacoronympha senta*, as in other Calonymphidae, the nuclei depart from their regular arrangement at the onset of division, and

are distributed irregularly in the peripheral cytoplasm. They were never observed deep in the endoplasm during nuclear division, though after it is completed (pl. 39, fig. 10) some often do occur in that position. Along with each nucleus go all other components of the karyomastigont. The axostyles were not visible in any of the stages of nuclear division.

Figure 3, pl. 39, shows nuclei in a very early prophase, the earliest one seen. The paradesmoses are comparatively very short. The nuclei have undergone no alteration in shape, but a granular structure in the central chromatin mass is more distinct than formerly. The central chromatin mass consists of a matrix substance and relatively large, peripherally located, deeply staining granules. In many of the nuclei five granules are present, as is true in almost all cases where the separate granules can be seen readily. In some of the karyomastigonts the old cresta is attached to one pole; in others it has been detached. The flagellate is evidently in a stage just at the time of degeneration of the old crestas. Some of those still present have a degenerate appearance, being somewhat misshapen, and in some they are not attached at the usual point.

A granule is situated close to each end of the paradesmose, connected by a filament, and to these granules flagella are attached in pairs (pl. 39, fig. 3, e). The old flagella have been distributed. New flagella and new crestas have not yet appeared.

Prophases with paradesmoses a little longer, and no trace of old or new crestas, are more frequent (pl. 39, figs. 4, 5). Probably, as is true in *devescovicinid* flagellates, the old flagella persist at the two poles. At what stage new ones grow out to complete the number could not be determined because of the small size of the division figures, and the usual presence of foreign organisms on the surface of the body. During the anaphase and telophase additional flagella are present.

New crestas, small in size and equal at the two poles, have appeared by the anaphase (pl. 39, fig. 6). In certain prophases possible new crestas, very small still, were seen, but it was difficult to be certain of the observation. Since they are present in the anaphase, however, there is no doubt that they develop during the prophase, after the old one has been discarded.

The crestas increase in size, and after the nuclei have divided reach the maximum length (pl. 39, fig. 8). The nuclei are still connected by the elongated paradesmose, which may have a length of four or five times the nuclear diameter. In late telophase nuclei, and sometimes in nuclei organized into spiral rows (pl. 39, fig. 9) the chromatin mass is composed of a matrix and usually five large, deeply staining granules, as in the prophase. The

usual presence of five granules in these stages may indicate the existence of five chromosomes, but no chromosomes have been seen in the anaphase.

The paradesmose eventually disappears. It does not give rise to new axostyles, as Janicki supposed, in *Devescovininae*. Although it has not been possible to determine this point conclusively in *Metacoronympha*, there is no doubt that the situation is the same as in *Devescovininae*.

The nuclei become grouped at opposite ends, though not in such regular arrangement as in *Coronympha*. No stages of division of the body were seen. In many specimens, however, on the slides on which division stages were numerous, the nuclei were distributed irregularly, not being arranged in spiral rows. It may reasonably be supposed that some of these are stages after plasmotomy. In that stage one would expect to find nuclei grouped without regular arrangement toward one end. In a prophase, when nuclei are also irregularly distributed, the paradesmose would be present. On this basis it may be assumed that pl. 39, fig. 10, represents such a post-division stage. The nuclear membranes are expanding in some mastigonts, and lie more or less adjacent to one another. As remarked above, this stage shows clearly the origin of the polygonal areas noted in vegetative individuals.

There are interesting problems in reorganization that have not been solved for lack of adequate material. The origin of the new parabasal apparatus is one. Janicki's account of this probably is correct. What factors determine that the nuclei shall usually be arranged in six spiral rows, and, conversely, what behavior results in a different number of rows? How does it happen that nuclei, crestas, and parabasal bodies are often smaller in the anterior karyomastigonts? In *Metacoronympha senta*, as in *Coronympha octonaria*, no evidence was found for division of non-dispersed nuclei. In division figures all dividing nuclei were of the same size in any one flagellate. How do differences in size arise, and how does it happen that nuclei arrange themselves so that there is a gradation in size along the spiral rows? What is the origin of the great diversity in number of nuclei? In all cases observed all the nuclei were dividing. May there be two or more successive divisions of nuclei, to increase the number in a small individual? May nuclear division take place, and rearrangement of nuclei occur, without being immediately followed by division of the body? May fission occur without being immediately preceded by nuclear division?

It is hoped that these questions can be answered after study of other Calonymphidae.

DIAGNOSES

It is necessary to revise the diagnosis of the genus *Coronympha*, given by the writer (1929), in order to permit the inclusion of the species described in this paper.

Coronympha Kirby, 1929

Multinucleate flagellates, with karyomastigonts arranged in a single circle in the anterior portion of the body; each karyomastigont consisting of a nucleus, blepharoplast, cresta, three anterior flagella, a trailing flagellum, a parabasal body and an axostyle; blepharoplasts in a small circle at the anterior end of the body; axostyles double-contoured, not gathered into a bundle, often project slightly from the posterior end; dividing nuclei become distributed generally in peripheral cytoplasm, mitotic figure with paradesmose and other features like those of devescovid flagellates.

Genotype.—*C. clevelandi* Kirby, 1929.

Coronympha clevelandi Kirby, 1929

Dimensions of body: length 25–53 μ , averaging 30 μ , width 18–46 μ , averaging 23 μ ; sixteen karyomastigonts; nuclei clavate, containing one or more nucleoli and finely distributed chromatin; crestas subtriangular, broader and flat in anterior portion; trailing flagellum a moderately stout cord; parabasal body rounded or bacilliform, situated peripheral and adjacent to nucleus, not exceeding its length; axostyles without enlarged cusps posteriorly, projecting from body; xylophagous.

Type host.—*Kalotermes clevelandi* Snyder, Panama.

Additional host.—*K. immigrans* Snyder, Fanning Island, Galapagos Islands.

Coronympha octonaria Kirby, new species

Dimensions of body²: length 19–40 μ , averaging 28 μ , width 12–26 μ , averaging 18 μ ; eight karyomastigonts usual, exceptionally ten or twelve; nuclei clavate; crestas somewhat larger, and broader anteriorly, than those of *C. clevelandi*; trailing flagellum like that of *C. clevelandi*; parabasal body bacilliform, ordinarily almost or quite as long as nucleus, sometimes exceeding length of nucleus, and incurved toward periphery of body; axostyles without enlarged cusps posteriorly, projecting from body; xylophagous.

Type host.—*Kalotermes emersoni* Light, Mexico.

Additional hosts.—*K. pacificus* Banks, Galapagos. *K. tabogae* Snyder, Panama. *K. platycephalus* Light, Mexico. *K. lighti* Snyder, Arizona.

² The dimensions here are for collective material from different host species; dimensions from individual species are given elsewhere.

Metacoronympha Kirby, new genus

Multinucleate flagellates with numerous karyomastigonts arranged in spiral rows meeting at the anterior end, averaging more than a hundred in the type species; each karyomastigont with nucleus, blepharoplast, cresta, three anterior flagella, a trailing flagellum and an axostyle; axostyles double-contoured as in *Coronympha*, distributed usually in outer endoplasm, not gathered into bundle, usually projecting a distance from the posterior end; nuclear division as in *Coronympha*.

Genotype.—*M. senta* Kirby, new species.

Metacoronympha senta Kirby, new species

Dimensions of body: length 22 to 92 μ , averaging 45 μ , width 15 to 67 μ , averaging 34 μ ; karyomastigonts 66 (or less) to 345 (or more), averaging about 150, arranged usually in 6 spiral rows, sometimes in 5, 7, 8, or 9 rows; nuclei ellipsoidal, membranes in vegetative individuals at anterior end often expanded and pressed together in polygonal form; crestas variable in size, some equal to those of *Coronympha octonaria*, broadened and flattened anteriorly in subtriangular form; trailing flagellum stouter than anterior flagella, but more slender than in *Coronympha clevelandi* and *C. octonaria*; parabasal body rounded or bacilliform, varying in size according to position of karyomastigonts; axostyles with enlarged cusps posteriorly, the tapering portion usually projecting beyond cytoplasm; xylophagous.

Type host.—*Kalotermes emersoni* Light, **Mexico**.

Additional hosts.—*K. pacificus* Banks, **Galapagos**. *K. tabogae* Snyder, **Panama**. *K. platycephalus* Light, **Mexico**. *K. lighti* Snyder, **Arizona**.

SUMMARY

1. Two new calonymphid flagellates, *Coronympha octonaria* Kirby, n. sp. and *Metacoronympha senta* Kirby, n. g., n. sp., are described from five termites of the genus *Kalotermes*, *K. emersoni* and *K. platycephalus* of Mexico, *K. pacificus* of the Galapagos Islands, *K. tabogae* of Panama (probably a synonym of *K. pacificus*), and *K. lighti* of Arizona.

2. *Coronympha octonaria* has eight karyomastigonts arranged in a circle. *Metacoronympha senta* has a large, variable number, averaging about 150, arranged generally in six spiral rows meeting at the anterior end.

3. Each karyomastigont has the structures of a devescovinid flagellate: three slender anterior and one stouter trailing flagellum, a sub-triangular, flattened cresta, a parabasal body, axostyle, blepharoplast and nucleus.

4. The axostyles run separately through the endoplasm, not being gathered into a bundle, and they project from the cytoplasm for a short distance. In *Metacoronympha* there is an enlarged posterior cusp, as in certain devescovinids and other flagellates of termites.

5. In division the nuclei lose their regular arrangement, to be distributed irregularly in the peripheral cytoplasm. The mitotic figure is like that in *devescovid* and *trichomonad* flagellates. The old cresta is resorbed and new ones form *de novo*. After the telophase, nuclei group at opposite ends and fission occurs.

6. *Coronympha* and *Metacoronympha* possibly have evolved from *devescovid* flagellates. They may be regarded as polymastigont *devescovid*ids, in the same way that *Microrhopalodina* is a polymastigont oxymonad.

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EXPLANATION OF PLATES

Abbreviations for methods of preparation: A.F., acid fuchsin; B., Bouin's fluid; D., Delafield's haematoxylin; F. G., Gatenby's modification of Flemming's fluid; H., Heidenhain's iron haematoxylin; S., Schaudinn's fluid.

PLATE 36

Figs. 1-8. *Coronympha octonaria* n.sp. Figs. 1, 2, and 5-8 from *Kaloterms emersoni*; fig. 3 from *K. platycephalus*; fig. 4 from *K. pacificus*. $\times 1830$.

Fig. 1. Entire, lateral view; crestas, axostyles, nuclei, and flagella. S.H.

Fig. 2. View from anterior end; blepharoplasts, nuclei, four flagella to each karyomastigont. S.H.

Fig. 3. Nucleus and long parabasal body. S.D.

Fig. 4. Nucleus and shorter parabasal body. B.D.

Fig. 5. Prophase, showing distribution of nuclei. S.H.

Fig. 6. Anaphase or early telophase. Old stout trailing flagellum attached at one pole. S.H.

Fig. 7. Late telophase; elongated paradesmose, new flagella. S.H.

Fig. 8. Just prior to cleavage; nuclei have completed division, are in circles at opposite ends. S.H.

Fig. 9. *Coronympha clevelandi* from *K. clevelandi*. S.H. $\times 1830$.

PLATE 37

Figs. 1-3, 5-6. *Metacoronympha senta* n.g., n. sp.

Fig. 1. From *K. emersoni*. Entire, of average size. S.H. $\times 970$.

Fig. 2. From *K. tabogae*. End view of a small individual, showing 66 nuclei in 5 rows. S.H. $\times 1335$.

Fig. 3. From *K. platycephalus*. Bacilliform parabasal bodies alongside nuclei. S.D. $\times 1830$.

Fig. 4. A, Three crestas of *Coronympha octonaria*; B, three of *C. clevelandi*; C, crestas of *Metacoronympha senta*, showing size variations. S.H. $\times 1830$.

Fig. 5. From *K. tabogae*. A small individual. F.G.H. $\times 1335$.

Fig. 6. From *K. tabogae*. A very large flagellate, with 345 nuclei, showing size variation in nuclei and parabasal bodies. S. D. $\times 880$.

PLATE 38

Metacoronympha senta n.g., n.sp.

Fig. 1. From *K. platycephalus*. B.H. $\times 1335$.

Fig. 2. From *K. emersoni*. Anterior end, showing beginning of the six spiral rows of nuclei, with polygonal compartments, formed by contiguous nuclear membranes, around the nuclear chromatin. S.H.A.F. $\times 1830$.

Fig. 3. From *K. platycephalus*. Anterior end, 144 nuclei in 7 rows; faintly stained parabasal bodies alongside many of the nuclei, a blepharoplast beside each. B.H. $\times 1335$.

Fig. 4. From *K. emersoni*. Nuclei all of same size, 95 in 6 rows. The nuclear membranes should, toward the center, be contiguous and somewhat polygonal, as in fig. 2. S.H. $\times 1830$.

Fig. 5. From *K. tabogae*. Endoplasmic inclusions of a crushed flagellate; fragments of wood, and residues of wood digestion. F.G.H. $\times 1830$.

PLATE 39

Metacoronympha senta n. g., n. sp.

Fig. 1. From *K. tabogae*. An individual with an unusually large number of karyomastigonts. Note variation in size of crestas. S.H. $\times 1335$.

Fig. 2. From *K. tabogae*. Spearhead-shaped cusps at posterior ends of axostyles. All axostyles of this flagellate are formed in this manner, with ends projecting from the cytoplasm. F.G.H. $\times 1830$.

Figs. 3-10. Division stages from *K. emersoni*. S.H. 23-29, $\times 1830$; 30, $\times 1335$.

Fig. 3. Early prophase; nuclei are distributed; all nuclei drawn are from one flagellate; old crestas attached to *b*, *c*, and *d*, absent from others; *e* showing granules separate from, but connected by fibrils to the ends of the paradesmose; five granules in each central chromatin mass.

Fig. 4. Prophase; paradesmose, granules and distributed flagella; no crestas.

Fig. 5. A little later prophase; no crestas.

Fig. 6. Anaphase; new crestas have developed.

Figs. 7, 8. Telophases; new crestas full grown.

Fig. 9. Two nuclei of late telophase, showing granules; five nuclei after arrangement in spiral rows, with five granules each.

Fig. 10. Probably after division of the body; karyomastigonts not yet organized into spiral rows; a few of the posterior karyomastigonts lie deep in the endoplasm.